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Jawaharlal Nehru

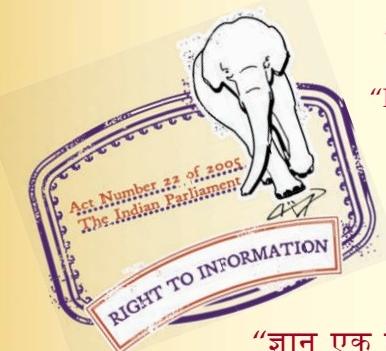
“Step Out From the Old to the New”

IS 8447 (1989): Manually operated voltage regulators for domestic use [ETD 16: Transformers]

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Satyanaaran Gangaram Pitroda

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Bhartṛhari—Nītiśatakam

“Knowledge is such a treasure which cannot be stolen”





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*Indian Standard*

**MANUALLY OPERATED VOLTAGE  
REGULATORS FOR DOMESTIC USE —  
SPECIFICATION**

( *First Revision* )

**भारतीय मानक**

**हस्त-चालित बोल्टता रेग्युलेशन, घरेलू उपयोग के लिये — विशिष्ट  
( पहला पुनरीक्षण )**

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**BUREAU OF INDIAN STANDARDS**  
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NEW DELHI 110002

## FOREWORD

This Indian Standard ( First Revision ) was adopted by the Bureau of Indian Standards on 15 June 1989, after the draft finalized by the Transformers Sectional Committee had been approved by the Electrotechnical Division Council.

This Standard was first published in 1977. This revision has been brought out to take into account the experience gained since then.

Manually operated voltage regulator basically consists of an auto-transformer with tappings for adjusting output voltage. Requirements of transformers are covered in IS 2026 ( Parts 1 to 4 ) issued in different parts. As such the requirements pertaining to transformers, have in general been aligned with appropriate part of IS 2026. Reference has also been made to IS 302 : 1979 at appropriate places in this standard.

IS 12360 : 1988 recognizes 240 V as the standard voltage for single-phase systems. It is observed that most of the equipment with which the manually operated voltage regulators are being used presently is, however, rated at 250 V and, therefore, 230 V has also been permitted as output voltage for such regulators.

The regulators covered in this standard are used for adjusting output voltage for a certain input voltage range. It is recommended that in case input voltage is below 160 V, a booster transformer may be used in series with the voltage regulator.

It is recommended that for appliances and equipment which function unattended, for example, refrigerators and air conditioners, only automatic regulators in accordance with IS 8448 : 1989 should be used.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

## *Indian Standard*

# MANUALLY OPERATED VOLTAGE REGULATORS FOR DOMESTIC USE — SPECIFICATION

*( First Revision )*

## **1 SCOPE**

**1.1** This standard covers manually operated voltage regulators (auto-transformer type) rated up to and including 5 kVA for single-phase operation for use with domestic equipment.

## **2 REFERENCES**

**2.1** The Indian Standards listed in Annex A are necessary adjuncts to this standard.

## **3 TERMINOLOGY**

**3.0** For the purpose of this standard the definitions given in IS 1885 (Part 38) : 1977, in addition to the following, shall apply.

### **3.1 Auto-Transformer**

A transformer in which at least two windings have a common part.

### **3.2 Manually Operated Voltage Regulator (Auto-Transformer Type)**

An auto-transformer wherein the output voltage being specified, the output to input voltage ratio can be varied in steps by a manually operated switch.

## **4 COOLING**

**4.1** The auto-transformer shall be of dry type with natural air cooling.

## **5 RATING**

### **5.1 Rated kVA**

The preferred ratings shall be 0.3, 0.5, 1, 1.5, 2, 3, 4 and 5 kVA.

### **5.2 Rated Voltage**

#### **5.2.1 Input Voltage Range**

Unless otherwise specified by the purchaser, the input voltage range shall be 160 to 260 V.

#### **5.2.2 Output Voltage**

The preferred output voltage shall be 240 V, but 230 V shall also be permissible (see foreword).

### **5.3 Rated Frequency**

The rated frequency shall be 50 Hz.

**NOTE** — Above are the preferred ratings, other ratings may be adopted as per the mutual agreement between the purchaser and the supplier.

## **6 CONSTRUCTION**

**6.1** The regulator shall have a suitable enclosure. The enclosure, if metallic, shall be adequately earthed.

**6.1.1** In order to reduce collection of dust, louvers, if any, shall be provided on the sides and not on the top of the voltage correctors.

**6.2** A rotary switch shall be provided to adjust the output voltage. The movement of the knob of the rotary switch shall be such that the output voltage increases when it is moved in clockwise direction. The rotary switch shall have stopping arrangement between the minimum and maximum output voltage positions so as to prevent a single step change from minimum to maximum and *vice versa*.

**6.3** Indicator plate shall be provided to indicate position of the rotary switch. A voltmeter of accuracy class index 2.5 [ see IS 1248 (Part 2) : 1983 ] shall be provided on the chassis to read the output voltage.

**6.4** A suitable indicator lamp to indicate that the unit is 'ON' shall be provided on the chassis.

**6.5** A fuse of suitable rating, calculated at the lowest specified input voltage shall be provided on the input side. The fuse unit shall conform to relevant Indian Standard wherever available.

**6.6** Regulators of ratings up to and including 2.5 kVA shall be provided with a power supply flexible cord of minimum length 1.5 m along with a three pin plug on input side and a socket on output side. The plugs and sockets shall be of 15 A rating and shall conform to IS 1293 : 1988. The flexible cord shall conform to IS 694 : 1977 or IS 9968 (Part 1) : 1988. The nominal cross-sectional area of flexible cord shall be chosen in accordance with 25.6 of IS 302 : 1979.

**6.7** Regulators of ratings above 2.5 kVA shall be provided with suitable terminals for input and output.

## **7 SAFETY REQUIREMENTS**

### **7.1 Protection Against Electric Shock**

Provisions of 8 of IS 302 : 1979 shall apply.

## **7.2 Leakage Current**

Provisions of **13.2** of IS 302 : 1979 shall apply.

## **7.3 Moisture Resistance**

Provisions of **15.4** of IS 302 : 1979 shall apply.

## **7.4 Stability**

Provisions of **20.1** of IS 302 : 1979 shall apply.

## **7.5 Mechanical Strength**

Provisions of **21** of IS 302 : 1979 shall apply.

## **7.6 Provision for Earthing**

Provisions of **27** of IS 302 : 1979 shall apply.

## **7.7 Screws and Connections**

Provisions of **28** of IS 302 : 1979 shall apply.

## **7.8 Creepage Distances and Clearances**

Provisions of **29** of IS 302 : 1979 shall apply.

## **8 LIMITS OF TEMPERATURE-RISE**

**8.1** The winding temperature-rise of the regulator above the cooling air temperature when tested in accordance with **11.7** shall not exceed the following values:

<i>Temperature Class of Insulation</i>	<i>Temperature-Rise °C</i>
A	50
E	65
B	70
F	90
H	115
C	140

NOTE — The reference temperature for the purpose of temperature-rise measurement is 45°C.

**8.2** During the temperature-rise test, the temperature-rise of the metallic enclosure, shall not be more than 20°C, above a reference temperature of 45°C.

## **9 PERFORMANCE REQUIREMENT**

**9.1** The regulator shall be able to adjust the output voltage within  $\pm 5$  percent of the rated output voltage (*see also 12.3*).

## **10 TERMINAL MARKING**

**10.1** Suitable markings shall be done on the regulator to indicate input and output terminals.

## **11 MARKING**

### **11.1 Rating Plate**

The regulator shall have the following information marked on it or on a label permanently attached to it:

- Manufacturer's name and country of manufacture;

- Manufacturer's serial number and type number, if any;
- Rated input voltage range;
- Rated output voltage;
- Rated frequency;
- Rated output current;
- Rated kVA; and
- Class of insulation.

## **12 TESTS**

**12.0** Unless otherwise specified, the test shall be carried out at manufacturer's works at room temperature.

### **12.1 Classification of Tests**

**12.1.1** The following shall comprise the type tests:

- Physical examination (*see 12.2*),
- Output voltage (*see 12.3*),
- Insulation resistance (*see 12.4*),
- High voltage (*see 12.5*),
- No-load current (*see 12.6*),
- Protection against electric shock (*see 7.1*),
- Stability (*see 7.4*),
- Mechanical strength (*see 7.5*),
- Provision for earthing (*see 7.6*),
- Screws and connections (*see 7.7*),
- Temperature-rise (*see 12.7*),
- Leakage current (*see 7.2*),
- Moisture resistance (*see 7.3*),
- Creepage distances and clearances (*see 7.8*),
- Induced voltage (*see 12.8*), and
- Endurance (*see 12.9*).

**12.1.1.1** Type tests shall be carried out on three regulators of the same rating and design. All samples shall pass all the tests mentioned in **12.1.1** for proving conformity with the requirement of this standard. If any of the samples fail in any of the type tests, testing authority, at its discretion, may call for fresh samples not exceeding twice the original number and subject them again to all the tests or test(s) in which failure(s) occurred. No single failure shall be permitted in the repeat test(s).

**12.1.2** The following shall comprise the acceptance tests:

- Physical examination (*see 12.2*),
- Output voltage (*see 12.3*),
- Insulation resistance (*see 12.4*),
- High voltage (*see 12.5*),
- No-load current (*see 12.6*),
- Protection against electric shock (*see 7.1*),
- Provision for earthing (*see 7.5*),
- Leakage current (*see 7.2*), and
- Induced voltage (*see 12.8*).

### **12.1.2.1 Number of samples and criteria for acceptance**

A recommended sampling plan for acceptance tests is given in Annex B.

### **12.1.3 The following shall comprise the routine tests and shall be carried out on all regulators:**

- a) Physical examination (*see 12.2*);
- b) Output voltage (*see 12.3*);
- c) Insulation resistance (*see 12.4*);
- d) High voltage (*see 12.5*); and
- e) No-load current (*see 12.6*).

### **12.2 Physical Examination**

The regulators shall be checked for conformity with **6, 10** and **11**.

### **12.3 Output Voltage Test**

**12.3.1** For this test, the voltmeter used shall be of accuracy not worse than class index 1 [*see IS 1248 (Part 2) : 1983*].

**12.3.2** The rated load shall be connected across the output terminals of the regulator. The input voltage shall be varied over the whole of rated input voltage range in not less than six steps. The output voltage at the switch position which gives output voltage nearest to the rated output shall be noted.

#### **12.3.2.1 Requirement**

The output voltage shall be in accordance with **9.1**.

**12.3.3** The minimum rated input voltage shall be supplied to the input terminals and the switch position shall be set for voltage nearest to the rated output voltage (*see 12.3.2*). A suitable load shall be connected to at the output terminals so that the current equal to five times the rated current flows through the output circuit. The output voltage shall be noted within a period not exceeding 15 seconds.

#### **12.3.3.1 Requirement**

The output voltage shall not fall below 195 V.

### **12.4 Insulation Resistance Test**

The insulation resistance between the terminals and body of the regulator shall be measured and recorded. It shall not be less than  $5 \text{ M}\Omega$  when measured at 500 V dc at room temperature not exceeding  $45^\circ\text{C}$ .

### **12.5 High Voltage Test**

A test voltage of  $2.5 \text{ kV}$  (rms) shall be applied at rated frequency for one minute between the winding and the body of the regulator which shall be earthed. This test shall be carried out immediately after the temperature-rise test. There shall be no disruptive discharge or collapse of test voltage.

### **12.6 No-Load Current Test**

The no-load current shall be measured at rated frequency with the rated maximum input voltage applied to the input terminals the output terminal being kept open-circuited. The no-load current shall not be more than 5 percent of the rated output current.

### **12.7 Temperature-Rise Test**

#### **12.7.1 Measurement of Temperature of Cooling Air**

The cooling air temperature shall be measured by means of several (at least three) thermometers placed at different points around the regulator, at a level approximately half way up the cooling surface, at a distance of 1 to 2 m from the cooling surface. The thermometers shall be protected from draught and abnormal heat radiation.

The value to be adopted for the temperature of the cooling air for the test is the average of the readings taken on these thermometers at equal intervals of time during the last quarter of the test period.

The temperature of the cooling air shall be as constant as possible during the test period, especially during the last quarter.

#### **12.7.2 Determination of Winding Temperature**

The winding temperature shall be measured using the resistance method. The temperature of a winding ( $\theta_2$ ) at the end of a test period shall be calculated from its measured resistance ( $R_2$ ) at the temperature and its measured resistance ( $R_1$ ) at some other temperature ( $\theta_1$ ) using the following formula:

$$\theta_2 = \frac{R_2 (235 + \theta_1)}{R_1} - 235 \text{ (for copper)}$$

$$\theta_2 = \frac{R_2 (225 + \theta_1)}{R_1} - 225 \text{ (for aluminium)}$$

where

$\theta_1$  and  $\theta_2$  are measured in  $^\circ\text{C}$ .

The measured temperature-rise of the windings shall not exceed the value given in **7.1**.

#### **12.7.3 Duration of Test of Temperature-Rise**

Evidence shall be obtained that the highest temperature-rise shall not exceed the value given in **7.1** even if the tests were continued until thermal equilibrium is reached. The winding temperatures shall be taken where possible during operation, as well as when the regulator is shutdown. The test shall not be regarded as completed until the temperature-rise increment is less than  $1^\circ\text{C}$  in 1 hour.

#### **12.7.4 Loading**

The minimum rated input voltage shall be

applied to the input terminals with the switch position set for rated output voltage and a suitable load shall be connected at the output terminals so that the rated current flows through the output circuit at rated output voltage.

#### **12.7.5 Temperature Correction for Cooling of Regulators after Shut-Down**

To provide for the interval between the instant of switching off the power and measurement of winding resistance of correction of  $1^{\circ}\text{C}$  per minute of time elapsing between shut-down and resistance measurement shall be added to the winding, temperature obtained from the resistance measurement.

#### **12.8 Induced Voltage Test**

To test the interturn insulation of the winding, an ac voltage of 500 V rms shall be applied to the output terminals of the winding. The test voltage shall be of a frequency of twice or more than twice of rated frequency. The test voltage

shall be applied for a duration of:

$$\frac{120 \times \text{rated frequency}}{\text{test frequency}} \text{ seconds}$$

but not less than 15 seconds. After this the regulator shall pass the no-load current test as specified in 12.6.

#### **12.9 Endurance Test**

The rotary switch shall be operated over the entire range of the regulator starting from minimum switch position to maximum switch position and back to the starting position. The movement of the rotary switch from the minimum switch position to maximum switch position and back to minimum switch position shall constitute one operation. One thousand such operations shall be carried out. The input voltage shall be kept at the lowest of the rated input voltage range. The power factor of test load shall be unity. The load shall be such that it takes rated current at the rated output voltage. The frequency of operation shall be limited to 100 operations per hour. After this test the regulator shall pass all the routine tests.

### **ANNEX A**

( Clause 2.1 )

#### **LIFT OF REFERRED INDIAN STANDARDS**

<i>IS No.</i>	<i>Title</i>	<i>IS No.</i>	<i>Title</i>
IS 302 : 1979	General and safety requirements for household and similar electrical appliances ( <i>fifth revision</i> )	IS 2026 ( Part 1 ) : 1977 ( Part 2 ) : 1977 ( Part 4 ) : 1977	Power transformers : Part 1 General ( <i>first revision</i> ) Temperature-rise ( <i>first revision</i> ) Terminal markings, tappings and connections ( <i>first revision</i> )
IS 694 : 1977	PVC insulated cables for working voltages up to and including 1 100 volts ( <i>second revision</i> )	IS 4905 : 1968	Methods for random sampling
IS 1248 ( Part 2 ) : 1983	Direct acting indicating analogue electrical-measuring instruments and their accessories: Part 2 Ammeters and voltmeters ( <i>second revision</i> )	IS 8448 : 1989	Automatic line voltage correctors ( <i>step type</i> ) for domestic use ( <i>first revision</i> )
IS 1271 : 1985	Thermal evaluation and classification of electrical insulation ( <i>first revision</i> )	IS 9968 ( Part 1 ) : 1988	Elastomer insulated cables : Part 1 For working voltages up to and including 1 100 volts ( <i>first revision</i> )
IS 1293 : 1988	Plugs and socket-outlets of 250 volts and rated current up to 16 amperes ( <i>second revision</i> )	IS 12360 : 1988	Voltage bands for electrical installations including preferred voltages and frequency
IS 1885 ( Part 38 ) : 1977	Electrotechnical vocabulary: Part 38 Transformers ( <i>first revision</i> )		

## ANNEX B

*( Clause 12.1.2.1 )*

### SAMPLING PROCEDURE FOR ACCEPTANCE TESTS

#### **B-1 LOT**

**B-1.1** In any consignment, all the regulators of the same type and rating manufactured from the same material under similar conditions are grouped together to constitute a lot.

#### **B-2 SELECTION OF SAMPLE**

**B-2.1** The number of regulators to be selected from the lot shall depend upon the size of the lot and shall be in accordance with col 1 and 2 of Table 1.

**B-2.1.1** These regulators shall be selected from the lot at random. For the purpose of random selection, reference may be made to IS 4905 : 1968.

#### **B-3 CRITERIA FOR CONFORMITY**

**B-3.1** The regulators selected in accordance with col 1 and 2 of Table 1 shall be subjected to the

acceptance tests specified in 12.1.2. A regulator failing to satisfy any one or more of the requirements of acceptance tests shall be termed as defective. The lot shall be considered as conforming to the requirements of acceptance tests if the number of defectives in the first sample is less than or equal to the acceptance number ( $a_1$ ) given in col 4 of Table 1. If the number of defectives is greater than or equal to the first rejection number ( $r_1$ ) given in col 5 of Table 1, the lot shall be considered as non-conforming to the requirements of acceptance tests. If the number of defectives is between acceptance number and first rejection number, the second sample ( $n_2$ ) of the same size shall be selected from the lot at random and subjected to the acceptance tests. The lot shall be considered as conforming to the requirements of acceptance tests if the number of defectives in the two samples combined is less than the second rejection ( $r_2$ ) given in col 6 of Table 1; otherwise not.

**Table 1 Sample Size and Criteria for Conformity**

*( Clauses B-2.1 and B-3.1 )*

Lot Size (N)	First Sample Size (1) (2)	Second Sample Size (3)	Acceptance Number (4)	First Rejection Number (5)	Second Rejection Number (6)
Up to 15	2	—	0	1	1
16 to 25	3	—	0	1	1
26 to 50	5	5	0	2	2
51 to 100	8	8	0	2	2
101 to 300	13	13	0	2	2
301 and above	20	20	0	3	4

NOTE — For lots of size up to 25, the decision about acceptance or rejection of the lot shall be taken on the basis of first sample only.

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### Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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**AMENDMENT NO. 1 MAY 1994**  
**TO**  
**IS 8447 : 1989 MANUALLY OPERATED VOLTAGE**  
**REGULATORS FOR DOMESTIC USE —**  
**SPECIFICATION**

*(First Revision)*

*(Foreword) — Insert the following new para after para 6:*

‘A scheme for labelling environment friendly products known as ECO Mark is introduced at the instance of the Ministry of Environment and Forests. The ECO Mark shall be administered by the Bureau of Indian Standards (BIS) under the BIS Act, 1986 as per the Resolution No. 71 dated 20 February 1991 published in the Gazette of the Government of India, under the Environment (Protection) Act, 1986. For a product to be eligible for ECO Mark, it shall comply with general requirements and product specific requirements. This amendment is, therefore, being issued to this standard in order to include the above mentioned requirements.’

*(Page 1, clause 6.5) — Substitute the following for the existing:*

‘Suitable protective devices like fuse, MCB meeting the requirements of appropriate standards shall be provided on the input side.’

*(Page 1, clause 6.6, line 6) — Substitute ‘suitable rating’ for ‘15 A’.*

*(Page 2, clause 9.1) — Add the following sub-clause after 9.1:*

**‘9.2 The efficiency of the unit shall not be less than 95 percent.’**

*(Page 2, clause 11) — Insert the following new clause after 11 and renumber the subsequent clauses:*

**‘12 CRITERIA FOR LABELLING ENVIRONMENT FRIENDLY PRODUCT**

**12.1 General Requirements**

**12.1.1** The regulator shall conform to the requirements pertaining to quality, safety and performance prescribed in this standard.

**12.1.2** The product manufacturer must produce the clearance as per the

provision of Water (PCP) Act, 1974, Water (PCP) Cess Act, 1977 and Air (PCP) Act, 1981, along with the authorization required under Environment (Protection) Act, 1986 and rules made thereunder to Bureau of Indian Standards while applying for the ECO Mark.

**12.1.3** The regulator packaging may display in brief the criteria based on which the product has been labelled environment friendly.

**12.1.4** The regulator shall be sold along with instructions for proper use so as to maximize product performance and minimize wastage.'

( *Page 3, clause 12.6* ) — Substitute '2.5' in place of '5' in the last sentence.

( ETD 16 )

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Reprography Unit, BIS, New Delhi, India